DOCUMENT RESUME

ED 338 501 SE 052 393

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TITLE The Illinois Rivers Project.
PUB DATE 90
NOTE 14p.
PUB TYPE Reports - Descriptive (141)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Computer Networks; Computer Uses in Education; Cultural Influences; Curriculum Development; Data Analysis; English; High Schools; *Interdisciplinary Approach; Middle Schools; Program Descriptions; Program Evaluation; *Science and Society; Science Education; Scientists; Social Studies; Student Attitudes; Student Projects; Teacher Characteristics; Telecommunications; *Water Quality; *Writing Across the Curriculum
IDENTIFIERS *Illinois

ABSTRACT

The Illinois Rivers Project was developed as an integrated, multidimensional science/technology/society pilot project designed to introduce water quality dimensions into Illinois high schools. The project involved high school science, social science, and English teachers in an integrated study of their local river and community. Science students conducted water quality tests; social studies classes evaluated the culture and historical impact of the river; and English classes processed the information into a collection of writings that spanned all aspects of river life. A key feature was the use of technology in the form of a computer network. The participating schools were able to communicate with each other via computer on water quality, problems, and successes. Specific goals addressed in the program include the following: (1) provide a working model so that Illinois high schools and middle schools can develop a science/technology/society unit based on water quality studies; (2) provide equipment and materials that represent the available technology in scientific water quality studies; (3) develop a vehicle for gathering data and applying skills gained in the social science (regarding water quality) to decision-making in real-life situations; (4) interpret written materials on river life and culture in such a way that students will be able to write well-organized and coherent materials for acceptance in the project publication, "Meanderings"; (5) develop an increased competency in microcomputer application and its role in data analysis; and (6) introduce project high school students and teachers to academic and industrial scientists, along with their equipment, so that they become aware of the work at the "cutting edge" of science. Data collected on student attitudes, student knowledge of water quality parameters and techniques, participating teachers, and an assessment of the instructional priorities of the teachers were used to evaluate the program. Student test results are summarized on seven tables. (18 references) (KR)

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THE ILLINOIS RIVERS PROJECT

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Introduction

Much attention recently has focused on the impending crisis facing the state of education and of the environment. Specifically, the problems that are manifested in document after document note the lowering of scientific literacy by American science students at all levels; others show that the tolerance levels for survival of living things along our greatest river, the Mississippi (and its tributaries), have reached an all time low. The simplest science and mathematics problems often pose insurmountable difficulties for today's students. At the same time, students who live next to the "Father of Waters" are unable to eat its catch due to increasing levels of pollution. In an effort to address educational and environmental concerns, the Illinois Rivers Project began a cooperative effort to save our rivers and at the same time address our children's scientific and environmental lifestyles. By using available scientific technology along with an existing computer network, this project incorporated the resources of selected high schools to begin the process of nurturing Illinois rivers. In the project, students gathered

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information by using chemical analysis, population sampling, cultural and historical analysis and by documenting their efforts through writing and filming.

Theoretical support for this project was not difficult to find. Documents such as Rutherford's 1985 report, Education for a Changing Future (better known as Project 2061 developed by AAAS), laid the blame for certain instructional problems on the methodology used by many high school teachers. Further documentation for this appeared in The Science Report Card (Mullis and Jenkins ,1988) which reported that both the content and structure of school science curricula are incongruous with the ideals of scientific enterprise. The findings presented in the Project 2061 document are consistent with the comments first recorded by the A Nation at Risk report that initiated the scientific community's self-evaluation. Subsequent and continuing evaluation of science programs, (Educating Americans for the 21st Century), as well as the State of Illinois program through which this program was funded, elicited similar responses and reported the problem's impact on the attainment of student's scientific literacy. A recent publication by the AAAS, The Liberal Art of Science: Agenda for Action stated that a "radical reform" must be undertaken from preschool through the university if people are to understand science and its influence on their lives.

Phi Delta Kappan (Fort, 1990), while highlighting scientific literacy, offered conceptual support for the Illinois Rivers Project in the statement, "The twin goals of achieving scientific literacy for all and encouraging excellence for the gifted are inextricably linked." While advanced science classes, consisting of second and third year students, are enrolled in the River Project, its very nature included a student population that is much broader. Student involvement spanned the additional curricular areas of social studies and English, thus assuring participation from students of all ability levels.

In terms of current topics for scientific study, the project's subjects, the Mississippi River and its tributaries, are under constant investigation. Jacques Cousteau's vessels and the Greenpeace *Rainbow Warrior* have made trips on the Mississippi to draw attention to

the river's problems. The Illinois EPA has finished a Low Water Quality Study of River in the St. Louis Area and is beginning a seven-year study along the river. The timing could not be better. The river needs attention and study, and thousands of high school students need a focus.

Program Description

The Illinois Rivers Project was developed as an integrated, multi-dimensional Science/Technology/ Society pilot project designed to introduce water quality dimensions into Illinois high schools. The River Project involved high school science, social science, and English teachers in an integrated study of their local river and community. Science students conducted water quality tests; social studies classes evaluated the culture and historical impact of the river; and English classes processed the information into a collection of writings that spanned all aspects of river life: past, present, and future. A key feature was the use of technology in the form of a computer network. The participating schools were able to communicate with each other via computer on water quality data, problems, and successes.

Specific goals addressed in the program:

1. Provide a working model so that Illinois high schools and middle schools can develop a science/technology/society unit based on water quality studies.

2. Provide equipment and materials that represent the available technology in scientific water quality studies.

3. Develop a vehicle for gathering data and applying skills gained in the social sciences (regarding water quality) to decision-making in real-life situations.

4. Interpret written materials on river life and culture in such a way that students will be able to write well-organized and coherent materials for acceptance in the project publication, Meanderings.

5. Develop an increased competency in microcomputer application and its role in data analysis.

6. Introduce project high school students and teachers to academic and industrial scientists, along with their equipment, so that they become aware of the work at the "cutting edge" of science.

The Illinois Rivers Project was initiated in 1989 and was funded by the Illinois State Board of Education Scientific Literacy Grant Program. The initial pilot program involved eight schools with 24 teachers and 380 students. Each of the eight initial project schools was required to complete four water quality tests on samples taken from the Mississippi and lower Illinois Rivers. The project also included several extended classroom activities. Many of these excursions were taken during field trips to the river banks; some involved visits by local industry; other outings were taken to water and river related industry and laboratories.

All eight schools assigned the students to collect river data of scientific, cultural, and historical significance. Telecommunication served a critical role in the program for disseminating the data collected by the students. Water monitoring data from nine water quality tests were collected by all schools. Testing was conducted on: dissolved oxygen content; fecal coliform; pH; biological oxygen demand; temperature; total phosphorous; nitrates; turbidity; and total solids. The test results were sent to Southern Illinois University at Edwardsville and then onto the University of Michigan computer system, CONFER, via modems provided by the project. A total of 141 tests were run by all participating schools. All data were archived and will become part of the overall data being accumulated and transmitted to the U.S. Fish and Wildlife Service for analysis and storage.

Project Outcomes

In the initial year of the Illinois Rivers Project, several benefits were evident. The project impacted teachers, students, and the community. The teachers who were involved in the program successfully collaborated with their colleagues in an interdisciplinary manner. In many cases, the nature of instruction was also affected by offering increased opportunities to students for experiential learning and field excursions.

Significant effects of the program on the participating students were evidenced in changes in students' attitudes toward science, in the extent of their involvement in field-based learning and in the dissemination methods utilized to share their experiences in the program. The students researched a variety of cultural and historical components related to the Mississippi River. Their original research was compiled into a 250 page publication called Meanderings. Each of the articles was a result of analysis by the students of the local river culture and history. The students also presented the specifics of the program to other school audiences. Each of the eight schools visited four other schools located along the Mississippi River for the purpose of sharing information about the program and for recruiting new schools into the project. Thirty-four schools were visited over a two-day period, with half-day presentations at each school. Twenty-seven of these schools enrolled and completed training in August as the newest members of the project.

The program's influence was also witnessed in the community. Each school was responsible for public awareness and presented programs to local businesses, as well as school and governmental agencies. Press releases were issued regularly though the University News Service at Southern Illinois University at Edwardsville. Student's stories on river-related projects became a regular feature in their local newspapers. Local television stations produced several reports on the students' testing of the river. One of

the teacher's comments on the Mississippi was accepted in the national magazine, Newsweek.

Program Evaluation

The program's effectiveness was monitored in several ways. Data were collected on student attitudes and measures were taken on student's knowledge of water quality parameters and techniques. A profile of the participating teachers was developed and an assessment of the instructional priorities of the teachers also was conducted. Tables and explanations of these assessments follow.

STUDENT ATTITUDE DATA

An attitude inventory was administered to the students in a pretest and posttest manner. A semantic differential format was used to elicit student attitudes to representative facets of the Illinois' Mississippi River Water Quality Monitoring Project. The categories contained word pairs which related to the topics of: Mississippi River; Field Work; Folklore; the Outdoors; and the Environment. Each word in the word pair represented an extreme sentiment. The students indicated their feelings along a five point continuum. The results of both pretest and posttest inventories and the degree of statistically significant change are presented in the following tables. All responses were coded and scaled with the number one (1) being the most negative and the number five (5) representing the most positive. Posttest results revealed a development of more positive attitudes for each of the five examined categories.

T Test Results of Student Attitudes

Mississippi River

Significant changes in students' perceptions of the quality and relevance of the Mississippi were evident. Positive shifts occurred in the posttest, registering that students indicated that the Mississippi River was healthy and clear. Posttest results also showed that the river was important.

Table 1
Mississippi River T Test Results

Item	Sex	n	Pre	SD	Post	SD	t
2	F	60	1.50	.72	1.55	0.67	0.45
2	M	45	1.24	.52	1.60	0.83	2.87**
6	F	60	4.48	.77	4.68	0.62	2.35*
6	M	45	4.24	.88	4.55	0.72	2.10*
7	F	60	2.16	.94	2.56	0.92	2.84**
7	M	45	1.88	.74	2.46	1.07	3.83***

* $p < .05$ ** $p < .01$ *** $p < .001$

Fieldwork

Most science courses do not have provisions for fieldwork. Because of this limitation, students could have negative attitudes toward fieldwork. In the pretest, some of the negative perceptions were stated. However, posttest responses showed significant changes in their views of fieldwork; seeing it as creative, relaxed, and safe.

Table 2
Fieldwork T Test Results

Item	Sex	n	Pre	SD	Post	SD	t
9	F	60	3.40	1.07	3.61	0.95	1.56
9	M	45	3.22	1.22	3.53	1.10	1.53
10	F	60	3.31	0.96	3.73	1.02	2.80**
10	M	45	3.28	1.14	3.33	1.14	0.22
12	F	60	3.38	0.90	3.53	0.98	1.20
12	M	45	3.04	1.14	3.40	1.03	1.94*

Folklore

Since legend and lore about the Mississippi River has historically contributed to the richness of the river, items soliciting students' attitudes about folklore were included. Posttest results showed that students found folklore exciting rather than boring, timely rather than untimely, and wise rather than foolish.

Table 3
Folklore T Test Result

Item	Sex	n	Pre	SD	Post	SD	t
17	F	59	3.32	1.00	3.59	0.81	1.99*
17	M	45	3.37	1.21	3.20	1.17	0.96
19	F	58	3.12	0.75	3.10	0.69	0.13
19	M	45	2.68	1.04	3.04	0.99	2.11*
20	F	59	3.23	0.83	3.81	0.86	3.91***
20	M	45	3.26	0.78	3.24	1.15	.010
24	F	59	3.42	0.95	3.37	0.88	0.39
24	M	44	3.00	0.88	3.45	0.90	2.38*

* $p < .05$ ** $p < .01$ *** $p < .001$

Outdoors

Among the goals of the River Project was the intent that students begin to develop an appreciation of the natural environment. Progress toward that goal was demonstrated in the students' responses that identified the outdoors as beautiful rather than ugly and familiar rather than strange.

Table 4
Outdoors T Test Results

Item	Sex	n	Pre	SD	Post	SD	t
29	F	60	3.55	1.12	3.38	1.07	1.03
29	M	45	3.35	1.22	3.75	1.06	1.89*
30	F	60	3.48	0.89	3.40	0.86	0.61
30	M	45	3.22	1.04	3.24	1.04	0.13
32	F	60	3.95	0.94	4.03	1.04	0.65
32	M	45	3.68	1.08	4.04	1.04	2.97**

Environment

Positive shifts in students' attitudes toward the environment were also registered. The students indicated that they thought that the environment was more certain than doubtful and was kinder than it was cruel.

Table 5
Environment T Test Results

Item	Sex	n	Pre	SD	Post	SD	t
33	F	60	3.05	0.91	2.85	0.88	1.45
33	M	45	2.48	0.89	2.97	0.98	2.83**
37	F	60	3.26	0.93	3.38	1.04	0.88
37	M	45	3.06	1.11	3.68	1.06	4.06***
40	F	60	3.15	0.82	3.36	0.84	1.61
40	M	45	3.11	0.93	3.33	1.02	1.43

* $p < .05$ ** $p < .01$ *** $p < .001$

Student Attitudes Towards Subject Areas

Students' attitudes towards the subject areas of chemistry, social studies, and writing were determined using an instrument developed by Silance and Remmers, "Attitude Towards Any Subject." This attitude test was administered to project participants using a pre/posttest format. Students were asked to respond to a series of comments related to each individual area: chemistry, social studies, and writing. Their individual score was the median value of their total responses.

T Test Results of Student Attitudes Towards Chemistry, Social Studies, and Writing

Students experienced positive changes in attitudes towards chemistry and social studies. Their attitude towards writing dropped slightly. The most significant change in student attitude was in chemistry. Results of the attitude pre/posttest are contained in Table 6 below.

Table 6
Student Attitude Towards Subject Area T Test Results

Subject Area	n	Pre	SD	Post	SD	t
Chemistry	144	8.02	1.28	7.53	1.82	4.20***
Social Studies	120	8.08	1.28	7.92	1.57	1.32
Writing	100	8.22	1.07	8.27	1.16	-0.58

* $p < .05$ ** $p < .01$ *** $p < .001$

Assessment of Student Knowledge of Water Quality Techniques

In an effort to obtain baseline data on students knowledge of water quality concepts and techniques, a 24 item inventory was administered to all students (N = 380), prior to their involvement in the Illinois' Mississippi River Water Quality Monitoring Project. The inventory included items which focused on the water chemistry field tests which the students would be conducting during the program. Two items were included for each of the targeted tests. A complete listing of: the items; targeted skill or water testing technique; and percent of students who responded to the correctly is presented in Table 7. As anticipated, low percentages of correct responses were apparent in the pretest. Although complete posttest data were not procured during the first year of the program, a concerted attempt to monitor student knowledge changes through pretest and posttest analysis is currently in operation.

Table 7
Assessment of Student Knowledge of Water Quality Techniques

Item	Technique/Skill	Percent Correct
1	Watershed information	82.5
2	Watershed identification	14.7
3	Monitoring	22.6
4	Monitoring	64.9
5	Sampling	36.0
6	Sampling	16.5
7	Dissolved Oxygen	14.7
8	Dissolved Oxygen	39.7
9	Fecal Coliform	58.4
10	Fecal Coliform	30.1
11	pH	33.1
12	pH	22.6
13	Biochemical Oxygen	36.8
14	Biochemical Oxygen	54.8
15	Temperature	35.8
16	Temperature	16.1
17	Total Phosphorous	14.6
18	Total Phosphorous	46.3
19	Nitrates	15.2
20	Nitrates	28.6
21	Turbidity	21.6
22	Turbidity	83.2
23	Total Solids	27.2
24	Total Solids	30.4

The Illinois Rivers Project is an exemplary Science/Technology/Society program that meets all the requirements for such programs as established by NSTA and by the AAAS Project 2061. Combining the science of the chemistry class in the study of the Mississippi and Illinois Rivers with the social studies and English classes allowed teachers and students to cross over traditional boundaries established by most high schools. Experiences of everyone involved with the project, including project staff, teachers, and students has been highly satisfactory. All participants have been captured by the project and its many avenues.

The greatest strength of this project was its ability to empower teachers to teach to the level of their training and capabilities. The time is right for environmental issues to be explored; it is right for telecommunication to be the method by which the project communicates internally; it is right because Meanderings allows other disciplines to become an integral part of the project. One conversation with an English teacher began, "I'm so excited to be asked to become involved in a science project. I have been teaching environmental literature for years and this is my first chance to be involved in a real project." The River Project is not just a science project; it is a real life project, about one of nature's gifts, the river, near which all of these kids and teachers live. Its fate may be their fate as they both move through time together.

The project's success can be measured by the change in attitudes of both students and teachers. The large quantity of writings submitted and water tests performed attest to that. The copies of news releases, articles, and television coverages indicate widespread community interest, as did the project being selected as the recipient of one of three Merit Awards from the Illinois Chapter of the Soil and Water Conservation Society. The project has also been nominated by this chapter for a national award.

The apparent ease with which teachers were recruited to the project should indicate success, as does the fact that English and social studies teachers joined science teachers in the effort. In the second year of the project, not a single school dropped out.

All of these successes occurred in a loose affiliation of schools whose commitment was not to the project as an administrative body, but rather to the ideology embraced by the project. The schools , with their teachers and students, have been given an opportunity to make a difference in their world. Furnished with the knowledge that good, creative teachers formed the backbone of the project, a few simple tools were given to them to complete the task. Along with the hard work and determination of these teachers and their students, through the students' research and writing, the string of high schools who have become "River Watchers" has grown from eight to 48 in one year. Is the project successful? Only when schools from Lake Itasca, Minnesota to Pilot Point, Louisiana begin watching the rivers will the goals of the project have been completely accomplished .

Implications

The success of the first year of the Illinois Rivers Project has been dominated in a large part by numbers. The years that follow must bring a new kind of organization to the project. The development of a "river curriculum" must be completed, along with extended units in geography, biology, and historical research. Contacts with other organizations conducting similar studies should be maintained and increased. Closer attachment to the international GREEN Network at the University of Michigan is a must. Two essential facets of the project must receive continued funding. Without the computer network, SOILED NET, and the production of student writings in Meanderings, the project would to resemble the often short-lived studies that run out of steam because they are without a long-range purpose.

By its very nature, this project has been both centralized and decentralized. For the project to continue, leadership must be developed in each state interested in establishing their own River Project . A site within each state will then take over the responsibilities of the computer network and Meanderings. Steps are currently being taken to establish headquarters in Minnesota, Wisconsin, and Iowa. The successful expansion of the River Project into other states forms the foundation of a workable dissemination model.

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